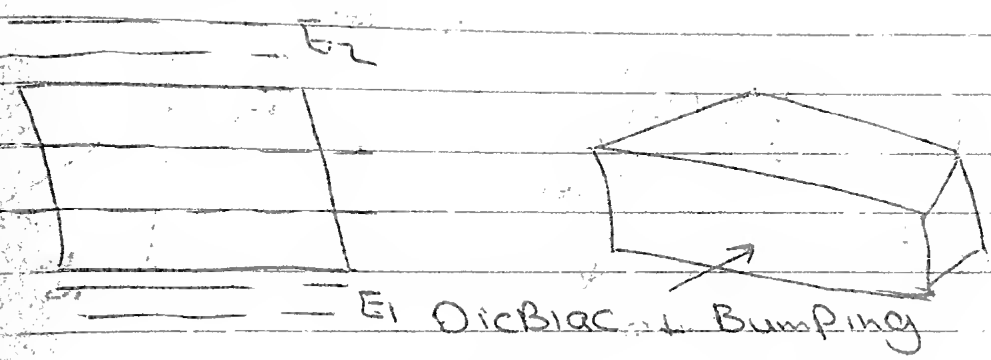
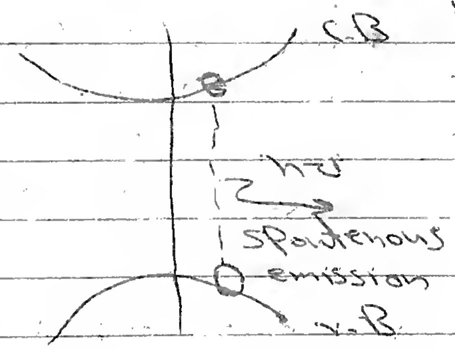
lec (13)

$P_e = e^{-h\nu/kT}$ At thermal Equilibrium

prob of emission at Quassi equilibrium



$f_c(E_2)\left[1 - f_v(E_1)\right]$



$= \frac{1}{e^{(E_2-E_{fc})/kT}+1}\left[1 - \frac{1}{e^{(E_1-E_{fv})/kT}+1}\right]$

$= \frac{1}{e^{(E_2-E_{fc})/kT}+1} \cdot \frac{e^{(E_1-E_{fv})/kT}}{e^{(E_1-E_{fv})/kT}+1}$

Apply Boltzmann Approx

$(E_2 - E_{fc}) \gg kT$

$|(E_1 - E_{fv})| \gg kT$

$= e^{-(E_2-E_{fc})/kT} \; e^{(E_1-E_{fv})/kT}$

$= e^{-(E_2-E_1)/kT} \; e^{(E_{fc}-E_{fv})/kT}$

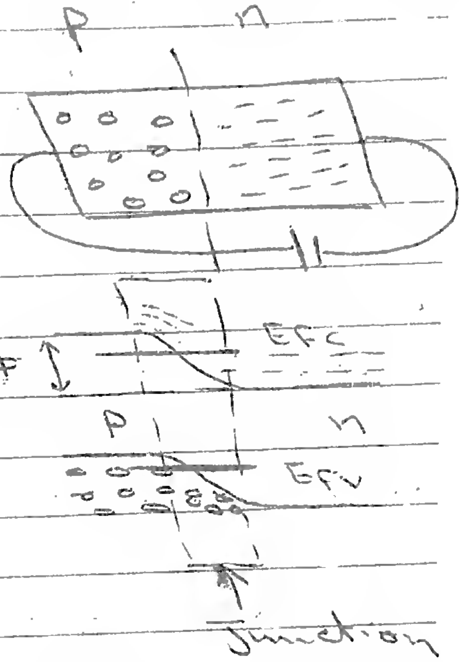
$P_e = e^{-h\nu/KT} \, e^{(E_{fc}-E_{fv})/KT}$

P_e

$\boxed{E_{fc} > E_{fv}}$

GaAs

لزيادة الامتصاص



نحضر p n وعطيها
Junct

Forword Bias

Rate of spontenous emission

أي إنبعاث

$$\mathcal{R}_{sp} = \frac{1}{\tau_r} \rho(\nu) P_e$$

$\rho(\nu) \equiv$ optical joint Density

$\tau_r \equiv$ time of Recombination

No of emitted Photons per unit time per unit volume per unit energy (freq)

$\rho(\nu) \rightarrow$ No of emitted or absorped Photon per unit volume per unit energy

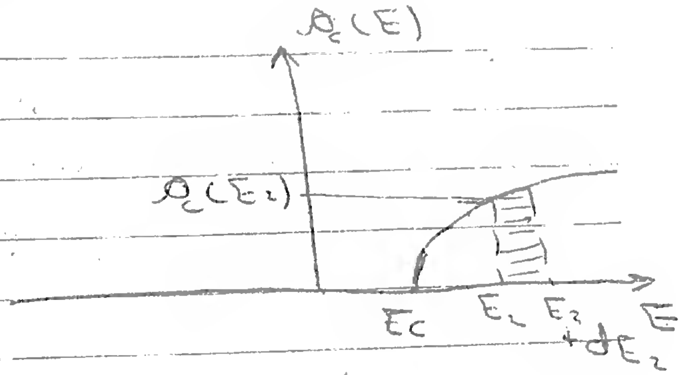
joint $\rightarrow$ 2 allowed states

نتيجة لانها تنقسم

بين ال cond و ال valan

No of allowed states ($E_2 \rightarrow E_2 + dE_2$)
per unit volume

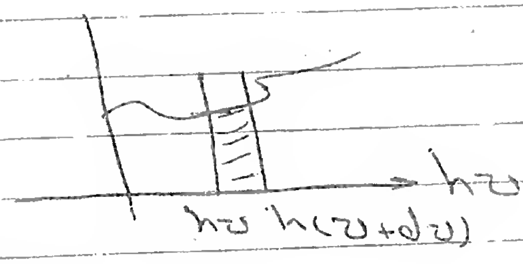
$= \rho_c(E_2)\, dE_2$



$\rho(\nu)\, d\nu$

per unit volume

Freq



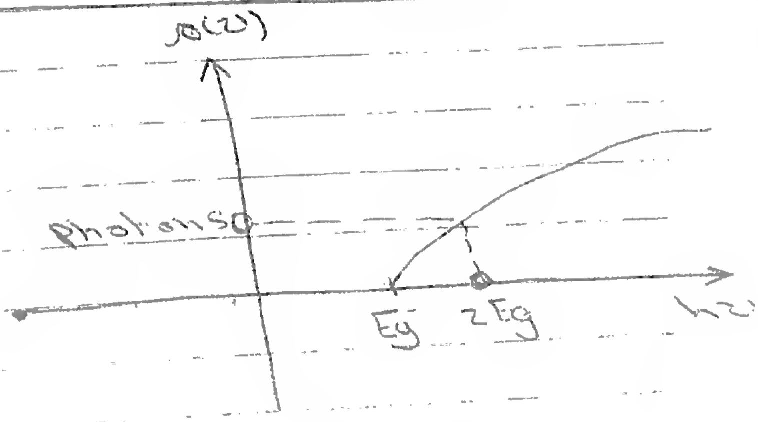
$\rho_c(E_2)\, dE_2 = \rho(\nu)\, d\nu$

$\rho(\nu) = \rho_c(E_2) \dfrac{dE_2}{d\nu}$

$\left(\dfrac{m_r}{m_c}\right)^{1/2} (h\nu - E_g)^{1/2}$

$\rho(\nu) = \dfrac{1}{2\pi^2} \left(\dfrac{2m_c}{\hbar^2}\right)^{3/2} (E_2 - E_c)^{1/2} \dfrac{m_r h}{m_c}$

$$\boxed{\rho(\nu) = \frac{1}{\pi \hbar^2} (2m_r)^{3/2} (h\nu - E_g)^{1/2}}$$



$$R_{sp} = \frac{1}{2\tau_r \pi \hbar^2}(2m_r)^{3/2}(-E_g + h\nu)^{1/2} e^{-h\nu/kT}$$

↳ rate of spontenous emission at thermal equlibrium

Quassi eq

$$R_{sp} * e^{(E_{fc} - E_{fv})/kT}$$

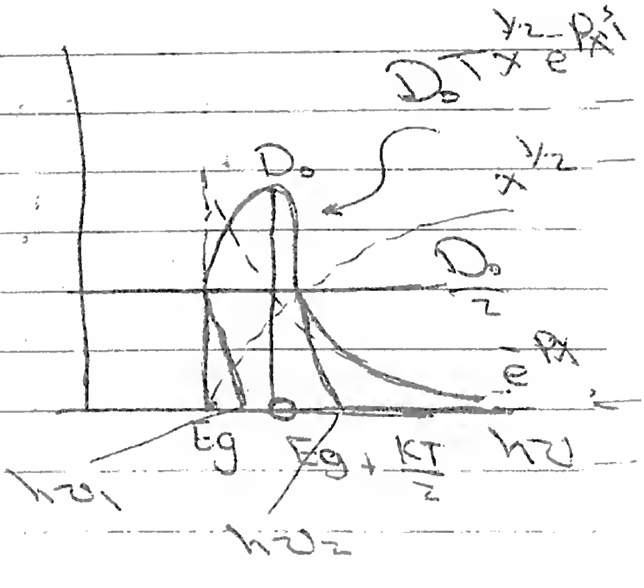
$$R_{sp} = \frac{1}{2\pi\hbar^2}(2m_r)^{3/2} e^{-E_g/kT}\left[(h\nu - E_g)^{1/2} e^{-(h\nu - E_g)/kT}\right]$$

$$R_{sp} = D_0 T\, x^{1/2} e^{-px} \qquad p = \frac{1}{kT}$$

$\frac{dR_{sp}}{d\nu} = 0 \rightarrow [h\nu]_p$

$= E_g + \frac{kT}{2}$

half power Beam width

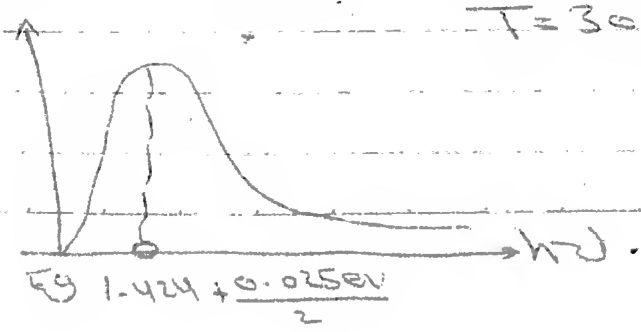


$\Delta\lambda = 1.45\, kT\lambda^2$

$\Delta\nu = 1.45\, kTc$

ex) GaAs $E_g = 1.424$ eV

$T = 300°K$



5

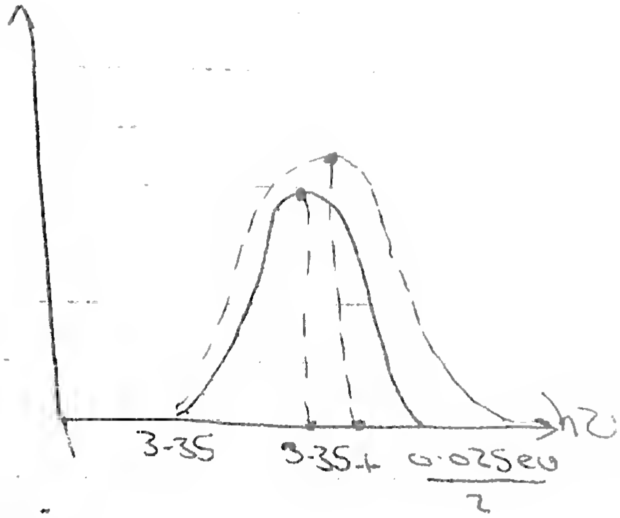
Subject :

Date :

GAN $E_g = 3.35\ eV$

$T \uparrow$ $\Omega_0 \uparrow$

$\Omega_0(T) \uparrow$ $BW \uparrow$



شروط خروج إشعاع من الطاقة

1) Semicond Direct mat.
2) Bumbing Forward Bias